

UNITED STATES SIGNAL SERVICE

MONTHLY WEATHER REVIEW.

VOL. XVI.

WASHINGTON CITY, AUGUST, 1888.

No. 8.

INTRODUCTION.

This REVIEW treats generally the meteorological conditions of the United States and Canada for August, 1888, and is based upon reports of regular and voluntary observers of both countries.

Descriptions of the storms that occurred over the north Atlantic Ocean are also given, and their approximate paths shown on chart i, on which also appears the distribution of icebergs and the limits of fog-belts west of the fortieth meridian.

The severest storm of the month occurred along the trans-Atlantic tracks east of the fortieth meridian from the 22d to the 24th, inclusive. No ice was reported, except along the coast of Newfoundland, in the vicinity of Belle Isle, and in Belle Isle Straits.

The month was warmer than the average on the north Pacific coast, in the region to the northward of Montana, and along the southwestern border from western Texas to the mouth of the Colorado River. The mean temperature was normal or below in all other districts, the region of greatest deficiency extending from the central Mississippi and lower Ohio valleys northwestward to Minnesota and Dakota.

The rainfall was deficient in portions of Florida and the south Atlantic states, in the Rio Grande Valley, in the region extending from the upper lakes westward to the Pacific coast, and in the central and southern plateau districts. The most important feature in connection with this subject was the remarkably heavy falls in the Gulf states, where more than double the average amount of rain fell. A marked excess over

the average also occurred in the southern slope, and in the Ohio and Missouri valleys.

Destructive freshets occurred in many portions of the Southern states as a result of the remarkably heavy rains which fell in that section.

Violent local storms were frequent during the month, those occurring on the 20th and 21st in the middle Atlantic states being, in some instances, the most severe that have occurred in that region for many years.

In the preparation of this REVIEW the following data, received up to September 20, 1888, have been used, viz., the regular tri-daily weather-charts, containing data of simultaneous observations taken at 133 Signal Service stations and 23 Canadian stations, as telegraphed to this office; 177 monthly journals and 176 monthly means from the former and 23 monthly means from the latter; 366 monthly registers from voluntary observers; 60 monthly registers from United States Army post surgeons; marine records; international simultaneous observations; marine reports through the co-operation of the Hydrographic Office, United States Navy, and the "New York Herald Weather Service;" monthly weather reports from the local weather services of Alabama, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New England, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, and Tennessee, and the Central Pacific Railway Company; trustworthy newspaper extracts, and special reports.

ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean atmospheric pressure for August, 1888, determined from observations taken daily at 8 a. m. and 8 p. m., is shown by isobarometric lines on chart ii. As the plan of taking tri-daily observations at Signal Service stations was on the 1st of July, 1888, superseded by that of taking but two at the hours stated, chart ii will in future exhibit mean pressures determined from two observations. A protracted series of hourly observations has shown that the difference between the mean pressure determined from two observations taken at the hours above named and that determined from tri-daily observations is so very slight as to be practically inappreciable.

As in the preceding month the regions of greatest mean pressure cover the south Atlantic and north Pacific coasts, where the barometric means reached 30.05, or slightly above. The pressure was, as is usual in August, least over the western part of the southern plateau, where the means fell to 29.8 and below. Yuma, Ariz., reported the lowest mean, 29.76, and Augusta, Ga., the highest, 30.09, giving a range of .33 for the whole country.

As compared with the preceding month the changes in mean pressure have been, in general, very slight, and over much of

the country the means for the two months were practically the same. In the west Gulf states and on the Pacific coast, from the Columbia River southward to central California, the August means averaged about .05 below those for July, while over the central Rocky Mountain slope they were about .05 higher, these changes representing the extreme departures as compared with July.

The departures from normal pressure at Signal Service stations are given in the table of miscellaneous meteorological data. Over the greater part of the country the departures from normal were unimportant. The greatest excess occurred in the south Atlantic coast and over the northern Rocky Mountain slope, and the greatest deficiency occurred in New England and the Canadian Maritime Provinces, the maximum excess being .06 and the maximum deficiency .08.

BAROMETRIC RANGES.

The monthly barometric ranges at the various Signal Service stations are also given in the table of miscellaneous meteorological data. The ranges, as usual, conform to the general rule, that is they increase with the latitude and decrease slightly, though somewhat irregularly, with increasing longitude. Along the Atlantic coast the extreme ranges are: .19 at Key West, Fla.,

and .79 at Portland, Me.; between the eighty-second and ninety-second meridians, .26 at Cedar Keys, Fla., and .84 at Louisville, Ky.; between the Mississippi River and Rocky Mountains, .32 at Rio Grande City, Tex., and .75 at Huron, Dak.; in the plateau regions, .30 at Yuma, Ariz., and .56 at Walla Walla, Wash.; on the Pacific coast, .22 at San Diego, Cal., and .52 at Port Angeles, Wash.

AREAS OF HIGH PRESSURE.

Five areas of high pressure traversed the country during the month. The general direction of their motion was towards the southeast. There is a marked tendency of the principal isobars in high areas at sometime in their existence to assume a triangular shape. This phase, as shown by the areas for July, 1888, generally follows soon after the occurrence of the highest winds associated with the area and which usually occur on its eastern side. This feature of triangular shaped high areas was noticeable in all of the areas of this month.

The table below gives the latitude and longitude to the nearest degree at which the centres of the high areas were first and last observed, the highest observed barometer accompanying each, the distance passed over by the centre, and the number of hours it took to describe it, and also the average hourly velocity of the centre in miles per hour:

Number of area.	First observed.		Last observed.		Highest reduced barometer reading.	Distance passed over.	Number of hours observed.	Average velocity per hour.
	Lat. N.	Long. W.	Lat. N.	Long. W.				
I.....	42	120	43	77	30.34	2625	84	30.1
II.....	48	90	33	76	30.38	2340	84	27.9
III.....	42	106	35	76	30.34	2280	108	20.1
IV.....	49	100	44	83	30.32	930	48	19.4
V.....	48	107	46	95	30.34	795	24	33.1

Average velocity of centre 25.8 miles per hour, equal to total miles divided by total hours. Average direction of motion 30° south of east.

The following is a general description of the progress of the high areas and the weather conditions attending them:

I.—This area first appeared in northern California, and, after moving for twelve hours in a northeasterly direction into Montana, then moved 30° south of east to northern Missouri; thence it pursued a course 13° north of east to central New York. High winds, forty-five miles an hour, occurred to the north of this area in Wyoming and Dakota previous to the triangular phase of the isobars, the formation of which took place on the 8th, when the 30.1 inch isobar included an area of about 240,000 square miles. Just before this a wind of fifty miles an hour occurred on its southeast side in northern Texas. The advance of the high was marked by slight falls of temperature to the east of it, not in many instances greater than 10° in twenty-four hours.

II.—This area first appeared on the 11th in western Lake Superior and disappeared off the coast of North Carolina on the 14th. Its general course was 40° south of east. Its triangular phase occurred on the 13th and is very conspicuous in the 30.1 inch isobar at the evening observation on that day. Just previously the wind was thirty-two miles an hour on its south side at Little Rock. There were at other places winds of thirty miles an hour. The rainfalls associated with this area on its eastern side were heavier on the Carolina coast than inland as the area approached the ocean. The slight (twenty-four hour) falls in temperature that took place during its progress were scarcely greater, on the average, than 10°.

III.—This area first appeared on the 20th in southeastern Wyoming. In the first twenty-four hours it moved only 100 miles. Its last appearance was on the coast of North Carolina on the 24th. The direction of its motion was 25° south of east. Very light rains occurred to the east and southeast of this area. Its triangular phase occurred in the 30.1 inch isobar, and also in the 30.2 inch, though less markedly, on the 22d. Previous to this the wind was thirty-five miles an hour

at Chicago and twenty-six miles at Grand Rapids, Mich. The attending twenty-four hour falls in temperature were usually not more than 10°, but there was one fall of 20° at Duluth on the 21st. The sky was uniformly clear in the area within the 30.2 inch isobar.

IV.—This area first appeared on the 26th in northern Dakota, and, after moving in a direction 25° south of east, disappeared on the 28th in eastern Michigan. No rain accompanied it except very far to the south. The attending winds were of moderate force, except on the 26th and 27th, when there was twenty-eight miles an hour on its eastern side at Port Huron. Its triangular phase occurred on the 28th in the 30.2 inch isobar. It was accompanied in its course by a fall of 20° in twenty-four hours in Manitoba, by a fall of 30° on Lake Superior, 20° in lower Michigan, and 10° farther to the southeast.

V.—This area first appeared in northeastern Montana on the 30th. After moving in a northeasterly direction for a day it then moved in a direction 60° south of east to central Minnesota, where it was at the 8 p. m. observation on the 31st. The only rain accompanying it was at Fort Buford, 0.06 inch, and at Bismarck, 0.02. The winds were mostly light, but twenty-six miles an hour occurred on the southeast side of it on the 30th in Minnesota and Dakota. A wind of thirty-five miles an hour occurred on its southeast side at Chicago on the 31st, just previously to the triangular phase of the 30.1 inch isobar, which included an area of 360,000 square miles. The sky was clear within this area, except at one station, Valentine, Nebr., on its western edge.

In the high areas of this month the pressures at the centres were always greater at the morning than the evening observation. For number iii the difference amounted on the 20th to 0.22 of an inch. This is probably due to the reduction of the barometer to sea-level. The current temperature of the air at the time of the observation is used as the temperature argument in deriving this reduction. This temperature is either too low at the 8 a. m. observation, thereby giving too great a reduction, or too high at the 8 p. m. observation, giving it too small. This is especially so for the far western stations, where 8 a. m. and p. m. seventy-fifth meridian times are about 6 a. m. and p. m. local times.

AREAS OF LOW PRESSURE.

On chart i will be found the approximate tracks of the centres of six areas of low pressure. The most important of these was number iv. This was a typical West Indian cyclone; its progress was the principal meteorological event of the month.

Area number iii presents the peculiarity of having traveled south from British America to western Texas, something unusual for this time of the year. It was not, however, a very well defined low. It was oblong and irregular in shape. Its longest axis extended from southwest to northeast. Its apparently devious course returning on its track in western Kansas may be due to the difficulty of locating its centre precisely.

The following table shows the latitude and longitude in which each centre of low pressure was first observed, the lowest pressure, the distance passed over by the centre, the number of hours observed, and the average velocity of centre, in miles per hour:

Number of area.	First observed.		Last observed.		Lowest reduced barometer reading.	Distance passed over by centre.	Number of hours observed.	Average velocity per hour.
	Lat. N.	Long. W.	Lat. N.	Long. W.				
I.....	41 30	100 30	43 30	68 30	29.62	1740	84	20.7
II.....	41 00	78 30	48 00	60 30	29.66	1150	48	23.9
III.....	48 30	102 00	31 30	105 00	29.64	1920	84	22.8
IV.....	25 30	79 30	46 30	61 00	29.38	3125	156	20.1
V.....	51 00	107 00	48 30	68 00	29.52	1900	72	26.4
VI.....	51 30	105 30	45 00	84 30	29.48	1080	36	30.1

Average rate of progress 22.7 miles per hour, equal to total distance divided by total hours.

In these descriptions where depths of rainfall are given they are for twelve hour periods:

I.—This area first appeared on the evening of the 1st in western Nebraska. It moved in a direction 14° north of east into the Province of Quebec. It then moved in a southeasterly direction and disappeared off the coast of Maine on the 5th. Its motion was more rapid in the middle part of its course through Wisconsin, Michigan, and Canada than at the beginning and end. It was accompanied by violent thunderstorms to the east of it, notably on the 1st at Saint Louis and at Louisville. The wind velocity at Saint Louis during the storm reached fifty-one miles an hour. The rainfall at both places was about 0.6 of an inch. A very remarkable display of lightning occurred at La Crosse during a thunderstorm from 2 a. m. to 4.30 a. m. of the 3d. The rainfall was 2.2 inches. Rains occurred on all sides of the area, and very strong winds, lasting, however, for only a short time. There was hail at Fort Maginnis in Montana to the north of it on the 2d. There were winds thirty-five miles an hour at Denver and Las Animas on the 1st to the southwest of it; forty miles an hour occurred at Chicago on the 2d to the east of it, and twenty-eight miles at La Crosse. On the 3d a velocity of sixty miles an hour occurred at Topeka and forty miles at Wichita, but these may have had some relation to an extensive low area with pressure of 29.8 to the southwest of Kansas which did not develop any proper motion.

II.—This area first appeared on the evening of the 12th in western Pennsylvania. It moved in a northeasterly direction across New York, Massachusetts, and Maine, and disappeared in the Gulf of Saint Lawrence on the 14th. The rainfall around it was mostly light. The heaviest occurred to the east of it. At Philadelphia the amount was 1.1 inches. Occasional strong winds occurred to the south of it. There was a rainfall of 2.0 inches at Oswego on 13th with wind velocity of forty-five miles an hour. Rain continued falling all around the low as it advanced and the winds increased in strength. A wind velocity of fifty miles an hour occurred at New York, forty miles at Eastport, thirty miles at Boston and Portland Me.

III.—This area first appeared in northern Dakota on the morning of the 13th and proceeded southward to western Texas, where it disappeared on the evening of the 16th. Rainfall occurred all around the centre, but over only a comparatively small area. There was a notably heavy wind at Moorhead, fifty-four miles an hour, but no rainfall. There was, however, a heavy hail-storm in its vicinity. The rain area continued small until the 14th when it spread out, there being rain from central Michigan to the Missouri River, and from southern Minnesota to southern Missouri. Winds of fifty miles an hour occurred at Fort Sully, Dak., and Valentine, Nebr., and thirty-five miles at Davenport, Iowa. On the 15th there was an extensive rain-area to the north of the low with rainfalls mostly light, except on its western edge, where there were falls of 1.8 inches at Fort McKinney and 2.5 inches at Rawlins.

IV.—This area was a typical cyclone, which described very nearly a parabolic path. Its apex was in southern Louisiana. One branch extended thence to the south of Florida and the other in a northeasterly direction across the United States and to the northeast of Nova Scotia. This area was first perceived off the southeast coast of Florida on the morning of the 16th. It moved in a direction 10° north of west for 950 miles before changing its course to the northeast. Its motion in this part of its path was only 11.3 miles per hour, much slower than in the other part of its path, where it was on the average 30.2 miles while moving in a northeasterly direction. Near the apex of parabola, where its direction of motion

changed, the centre described only 375 miles in two days. When started in a northeasterly direction its motion became gradually faster. From 8 a. m. of the 21st to 8 a. m. of the 22d it passed over 970 miles, or a little more than forty miles an hour. While the low was in the southern part of its path there was a high of 30.2 inches covering part of North Carolina, South Carolina, and Georgia, and extending into the ocean. Around this high area the low seemed to move. Throughout the whole course of the low area there were heavy rainfalls and high winds around the centre. The rainfall in southern part of Louisiana and Mississippi for the month was excessive, a great deal of it occurring in connection with this storm. On the 16th the wind reached sixty miles an hour at Point Jupiter on the Florida coast, and the rainfall was 2.02 inches. On the 18th the rain area extended up the Mississippi and Ohio River valleys. The winds were very strong on the Gulf coast on the 19th and 20th, reaching sixty miles an hour at Pensacola and fifty-five miles at Mobile on the southeast side of the low at a distance of 300 miles from the centre. At New Orleans the rainfall measured at 8 a. m. for previous twelve hours was 7.9 inches, and the wind was estimated to have blown at the rate of ninety miles an hour from 3.30 to 4 a. m. The anemometer connection with self-register was broken by the storm. Great damage was done by the storm in the city and vicinity. The further course of the storm was marked by heavy rainfalls over extensive areas, as for instance 2.0 inches from Louisville to Cincinnati and 3.25 inches at Norfolk. High winds also occurred at a greater number of stations as the storm advanced. There was a wind velocity of fifty miles an hour at Nashville and Knoxville, and forty miles at Norfolk and Block Island, and high winds all along the intermediate coast on the 21st. High northerly winds also prevailed in the Lake region on the 21st and 22d, reaching thirty-five miles an hour at Port Huron and Chicago and thirty miles at Oswego. These winds on the lakes were probably related also to the high area number iii. On the 22d there was a velocity of fifty miles an hour at Eastport and Block Island, and thirty-five miles an hour at New York. On the 21st, in connection with this low and to the east of it, there was a series of tornadoes in eastern Maryland, accompanied by intense thunder and lightning. A marked feature of the air in the surrounding country just before the occurrence of the tornadoes was the excessive humidity. At Baltimore it was 95 per cent. of saturation. The maximum temperature was not so very high. Late in the afternoon it was only $82^{\circ}.4$. There were no very marked twenty-hour hour falls in temperature in the country over which the cyclone passed.

V.—This area first appeared to the north of Montana on the 24th, and moving in a direction slightly south of east, disappeared in the Gulf of Saint Lawrence. Only a very slight rainfall in western New York occurred in connection with it. There followed in its wake, associated also with high area number iv on its eastern side, a very considerable twenty-four-hour fall in temperature, amounting to 30° on the 26th in northern Michigan and 20° later on farther to the east.

VI.—This area first appeared to the north of Montana on the morning of the 29th. It traveled southeast, and the centre was in northern Michigan at the evening observation of the 31st. There were light rains at two stations in Michigan on the 30th. On the 31st the area spread out into a very extensive one of low pressure, the 29.9 inch isobar including a stretch of country about two hundred miles wide extending from the Gulf of Saint Lawrence through the region of the Great Lakes and down the Mississippi Valley to the Gulf of Mexico. This area was not attended by any notable changes in temperature.

NORTH ATLANTIC STORMS FOR AUGUST, 1888.

[Pressure in inches and millimetres; wind-force by Beaufort scale.]

The paths of the depressions that appeared over the north Atlantic Ocean during August, 1888, have been determined

from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-